Chapter 4

Molarity and Solubility rules
Dr. Stone
CHEM 1100

Molarity, M

Molarity is the moles of solute per liter of solution.

$$\frac{\text{Moles}}{\text{L}} = \text{M}$$

What is the molarity of a solution made by adding 25 grams of sodium chloride to 500 mL of water?

A. 3.4×10^{-2} B. 5.0×10^{-2} C. 4.27×10^{-1} D. 2.9×10^{1}

$$25 \text{ g NaCl} \times \frac{1 \text{ mole NaCl}}{58.5 \text{g}} \times \frac{1}{500 \text{ mL}} \times \frac{1000 \text{mL}}{\text{L}} = 3.4 \times 10^{-2}$$

Titration of KHP with NaOH

$KC_8H_5O_{4(aq)} + NaOH_{(aq)} \rightarrow H_20_{(l)} + KNaC_8H_4O_{4(aq)}$

acid + base → water + salt

<u>Balanced Ionic equation:</u>

$K^+_{(aq)} + C_8H_5O_4{}^-{}_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow H_20_{(l)} + K^+_{(aq)} + Na^+_{(aq)} + C_8H_4O_4{}^{-2}{}_{(aq)}$

What is the same for both the reactants and the products?

$K^+_{(aq)} + C_8H_5O_4{}^-{}_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow H_20_{(l)} + K^+_{(aq)} + Na^+_{(aq)} + C_8H_4O_4{}^{-2}{}_{(aq)}$

What is different? What changes?

$K^+_{(aq)} + C_8H_5O_4{}^-{}_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow H_20_{(l)} + K^+_{(aq)} + Na^+_{(aq)} + C_8H_4O_4{}^{-2}{}_{(aq)}$

<u>Net ionic equation (remove spectators)</u>

$C_8H_5O_4{}^-{}_{(aq)} + OH^-_{(aq)} \rightarrow H_20_{(l)} + C_8H_4O_4{}^{-2}{}_{(aq)}$

Titration of KHP with NaOH

It takes 32.56 mL of a sodium hydroxide solution to reach the end point of a titration of 25.00 mL of KHP. The concentration of KHP is 40.84g/L. What is the molarity of a sodium hydroxide solution?

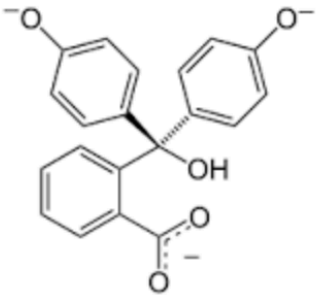
$KC_8H_5O_{4(aq)} + NaOH_{(aq)} \rightarrow NaKC_8H_5O_{4(aq)} + H_20_{(l)}$

End point is when the moles of KHP = mole of NaOH

Use an indicator to detect a very slight excess of hydroxide ions.

Phenolphthalein turns
pink with excess base
Use volume of NaOH at
The end point to determine
The molarity of NaOH.

Phenolphthalein is a chemical compound with the formula $C_{20}H_{14}O_4$ and is often written as "HIn" or "phph" in shorthand notation. **Phenolphthalein** is often used as an indicator in acid–base titrations. For this application, it turns colorless in acidic solutions and pink in basic solutions.



Phenolphthalein - Wikipedia
https://en.wikipedia.org/wiki/Phenolphthalein

Titration of KHP with NaOH

It takes 32.56 mL of a sodium hydroxide solution to reach the end point of a titration of 25.00 mL of KHP. The concentration of KHP is 40.84g/L. What is the molarity of a sodium hydroxide solution?

$KC_8H_4O_{(aq)} + NaOH_{(aq)} \rightarrow NaKC_8H_4O_{(aq)} + H_20_{(l)}$

End point is when the moles of KHP = mole of NaOH

Need: $\frac{\text{moles of NaOH}}{\text{volume of NaOH}}$

Have: moles of NaOH = moles of KHP at end point

Moles of KHP = volume x Molarity KHP

Convert 40.84g/L to moles per liter:

$\frac{40.84 \text{ g KHP}}{\text{L}} \times \frac{1 \text{ mole}}{204.2 \text{ g}} = 2.000 \times 10^{-1} \text{M KHP}$

Volume KHP x M KHP = moles KHP

$25.00 \text{ mL KHP} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{2.000 \times 10^{-1} \text{ moles KHP}}{\text{L}} = 5.000 \times 10^{-3} \text{ moles KHP} = 5.000 \times 10^{-3} \text{ moles NaOH}$

Volume of NaOH at endpoint = 32.56

$\text{Molarity of NaOH} = \frac{5.000 \times 10^{-3} \text{ moles NaOH}}{32.56 \text{ mL}} \times \frac{1000 \text{ mL}}{\text{L}} = 1.536 \times 10^{-1} \text{ M}$

Titration of KHP with NaOH

It takes 22.12 mL of a sodium hydroxide solution to reach the end point of a titration of 20.00 mL of KHP. The concentration of KHP is 20.11g/L. What is the molarity of a sodium hydroxide solution?

A. 8.904×10^{-2}M B. 1.123×10^{1}M C. 1.089×10^{-1}M
D. 9.18M E. None of these

Titration of KHP with NaOH

It takes 22.12 mL of a sodium hydroxide solution to reach the end point of a titration of 20.00 mL of KHP. The concentration of KHP is 20.11g/L. What is the molarity of a sodium hydroxide solution?

$KC_8H_4O_{(aq)} + NaOH_{(aq)} \rightarrow NaKC_8H_4O_{(aq)} + H_20_{(l)}$

End point is when the moles of KHP = mole of NaOH

Need: $\frac{\text{moles of NaOH}}{\text{volume of NaOH}}$

Have: moles of NaOH = moles of KHP at end point

Moles of KHP = volume x Molarity KHP

Convert 20.11g/L to moles per liter:

$\frac{\text{g}}{\text{L}} \times \frac{1 \text{ mole}}{204.2 \text{ g}} = \text{\_\_\_\_\_ M KHP}$

Volume KHP x M KHP = moles KHP

$\text{\_\_\_\_\_} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{\text{moles KHP}}{\text{L}} = 5.000 \times 10^{-3} \text{ moles KHP} = 5.000 \times 10^{-3} \text{ moles NaOH}$

Volume of NaOH at endpoint = _____.

Molarity of NaOH = $\frac{\text{moles NaOH}}{\text{Endpoint mL}} \times \frac{1000 \text{ mL}}{\text{L}} =$

A. 8.904×10^{-2}M B. 1.123×10^{1}M C. 1.089×10^{-1}M D. 9.18M E. None of these

Titration of KHP with NaOH

It takes 22.12 mL of a sodium hydroxide solution to reach the end point of a titration of 20.00 mL of KHP. The concentration of KHP is 20.11g/L. What is the molarity of a sodium hydroxide solution?

$KC_8H_4O_{(aq)} + NaOH_{(aq)} \rightarrow NaKC_8H_4O_{(aq)} + H_20_{(l)}$

End point is when the moles of KHP = mole of NaOH

Need: $\frac{\text{moles of NaOH}}{\text{volume of NaOH}}$

Have: moles of NaOH = moles of KHP at end point

Moles of KHP = volume x Molarity KHP

Convert 20.11g/L to moles per liter:

$\frac{20.11\ g}{L} \times \frac{1\ \text{mole}}{204.2\ g} = \frac{0.09848}{}$ M KHP

Volume KHP x M KHP = moles KHP

$20.00\text{mL} \times \frac{1\ L}{1000\ \text{mL}} \times \frac{0.09848\ \text{moles KHP}}{L} = 1.9696 \times 10^{-3}\ \text{moles KHP} = 1.9696 \times 10^{-3}\ \text{moles NaOH}$

Volume of NaOH at endpoint = 22.12 mL

$\text{Molarity of NaOH} = \frac{1.9696 \times 10^{-3}\ \text{moles/L NaOH}}{22.12\ \text{mL}} \times \frac{1000\ \text{mL}}{L} = 8.904 \times 10^{-2}\text{M}$

A. 8.904×10^{-2}M B. 1.123×10^{1}M C. 1.089×10^{-1}M D. 9.18M E. None of these

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- https://quizlet.com/class/7860422/